



by AIR CHIEF MARSHAL SIR R. BROOKE-POPHAM,
GCVO, KCB, CMG, DSO, AFC.

3 Native drivers.)	Desert
) Frontier
One Orderly.)	Administration.

3. The party left Siwa on Saturday 28th. December, and reached Siwa again on the return journey at 0915 hours on Thursday, 2nd. January. The total distance covered by speedometer was 824 kilometres. The halts for the night were at the following places:-

How. run

119

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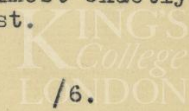
151

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52

5. As one goes further south the dunes gradually become more regular and from about 20 miles south of Siwa onwards form lines running almost exactly parallel from North by West to South by East.



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6. The original surface of the sand sea was apparently lime stone. The height of the sand dune above the lime stone may be anything from 100 to 300 feet. Throughout the greater part of the area we crossed, a section of the dunes would resemble a ratchet with the steel side of the ratchet facing east. The edge of the ratchet would be formed by dunes, and sand appeared to have blown up against these dunes from the West. A car travelling east and approaching a sand dune from the west would go up a more or less regular slope and at the end would reach a light coloured crest of soft sand. Walking to the top of this sand and looking over, one could see what appeared to be a deep valley at the bottom of a deep sand slope. Beyond the valley would again be an area of sand steadily rising towards the West and again ending in a dune line. It was comparatively easy to reach the top of the dune by car from the West, but almost impossible to get down. Occasionally a pass down the dune would be found, but normally it was necessary to go round the end of it. Some of the dunes encountered during the first three days were found to be 15 kilometres in length and these appeared to be about the normal. The width between the dune lines varied. In some cases it was as much as 8 kilometres and others about 2. On a few occasions, especially during the second day's journey, dunes running at right angles to the normal direction were encountered which occasionally reached as far as the next line of dunes.

7. Generally speaking, movement towards the North or South, i.e., parallel with the lines of dunes, is easy; movement in an Easterly or Westerly direction is difficult, and entails long detours. But it would probably be easier to move Westwards than Eastwards, because from the east it is easier to detect any passes through the dunes. Movement would be impossible for any car not fitted with low pressure tyres.

8. Direction was kept mainly by means of a sun compass, but this is difficult to follow for an hour after sunrise and for an hour before sunset. Dead reckonings were recorded and checked by astronomical observation. On one occasion the dead reckoning was 10 miles out, on other days it was six or less.

9. Patches of soft sand in which cars with even low pressure tyres sink may be encountered anywhere. Bushes generally indicate the presence of soft sand. Soft patches were also frequently encountered on sloping sand about 500 yards west of a sand dune. Cars should keep a fair distance apart, e.g. 200 yards, so that if the preceding car sticks in soft sand the others may be able to make a detour and avoid it.

I was unable to detect any indication of the presence of soft sand other than by the presence of bushes, but a whale-back was generally

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firm going and sand with irregular ripples almost always had a firm surface.

10. The important thing to avoid is breaking through the surface of the sand. Drivers therefore must be careful not to use the brake, to let in the clutch very gently, and avoid changing gear on a slope.

11. When a car does get stuck it is necessary to lift as well as push.

12. There is a regular series of passes through the sand dunes about latitude 27° .

13. On the nights of December 30/31st. and December 31st/January 1st., there was dew. It was heavy on the second night and for about an hour after sunrise the surface of the sand was wet to a depth of perhaps $\frac{1}{32}$ nd. of an inch.

14. The surface of the sand is firmer when cold than when hot, therefore travelling is easier before noon than it is afterwards.

15. For some distance east of longitude $26^{\circ} 30'$ most of the dunes were much shorter than further West, some of them being only about one kilometre in length. On the eastern edge of the sand sea, however, the dunes again became much longer.

16. At the time of the year that our journey was made the question to be faced as regards comfort is one of cold rather than heat. Although the sun is hot the air is very cold except between 1 o'clock and 3.30. Warm clothes were therefore necessary in the car, and still more so by night. If tents can be taken, it is an advantage to pitch them before the sun goes off the sand as the sand then appears to retain the heat, whereas once the sun is off, the sand cools down very quickly. On this account therefore, it is desirable to pitch camp on the Western edge of the sand dune, but it is more important to get shelter from the wind than to have the advantage of the sun.

17. Signs of life were never entirely absent during any part of our journey. Bushes were seen not only in the valleys but sometimes near the top of the sand dunes. Around most of the bushes could be seen traces of birds and some whitened bones. These were probably of migratory birds. A feather believed to be that of an owl was picked up whilst being blown south by the wind about 100 miles south of Siwa. Most of the bushes are distinctly aromatic when twigs are broken off and the scent remains in the wood for several days.

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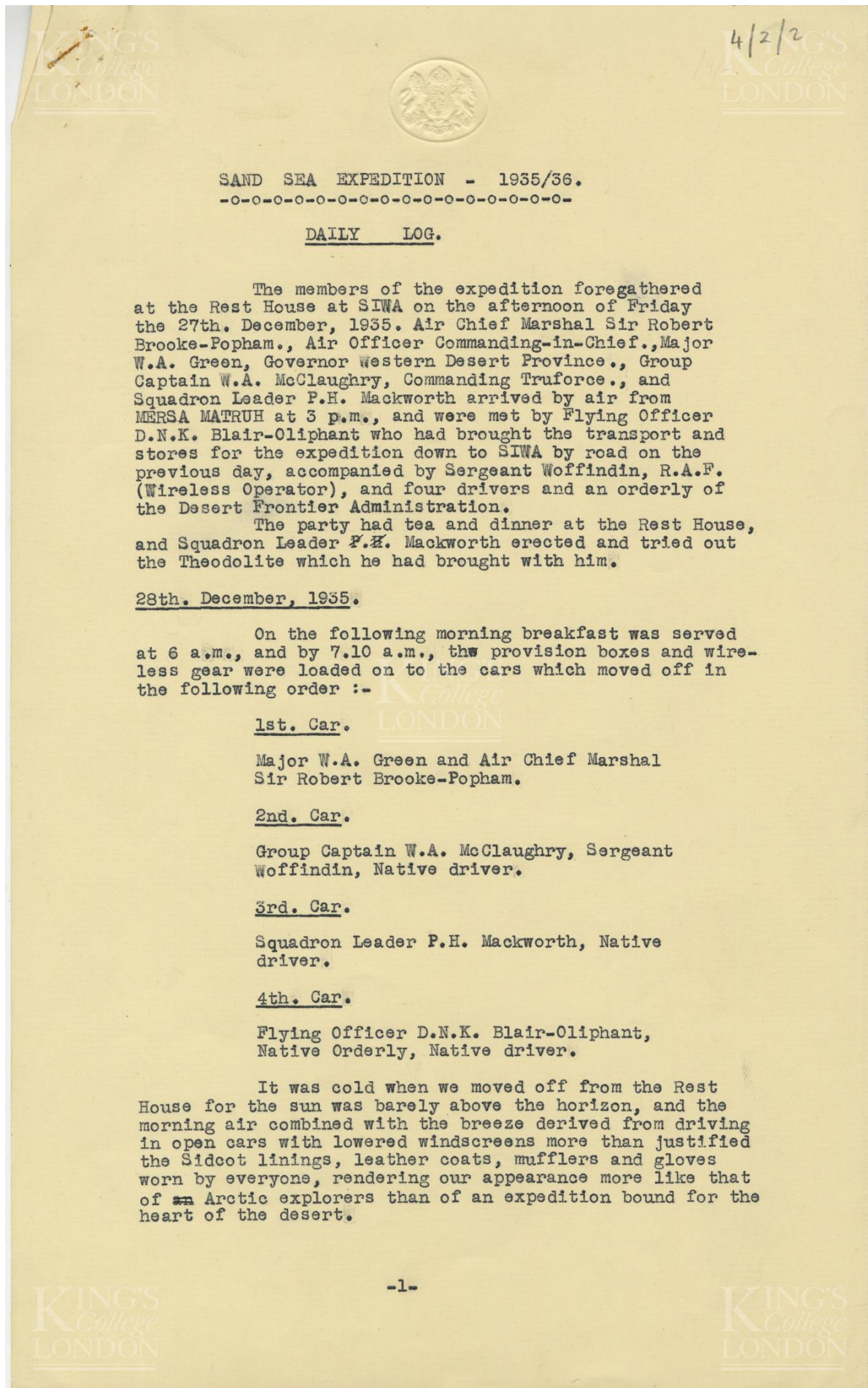
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18. One of the difficulties of driving in the desert is due to the fact that the colour is generally very uniform, and this, combined with the glare, makes it very difficult to perceive gradients; generally speaking, the slopes appear much steeper than they really are. It is also quite easy to be false crested. A stretch of desert that looks perfectly flat may in reality contain a deep dip but, for the reasons given above, the near edge of the dip merges into the far edge, so that, to the eye, they appear to form one continuous surface.

19. The degree of slope of dips frequently varies within a short space and this especially applies to a moon-shaped dip curving in towards the line of approach, i.e. forming a re-entrant. The leading car may descend on a gentle slope but a few yards to right or left may be uncomfortably steep. The main danger of a steep slope is that if the sand is soft the car may get completely out of control, swing sideways and topple over.

I measured the distance of sand disturbance caused by the wheels of a car on one occasion & made it 5 ft 9" from the centre of the wheel track

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But if people felt cold they were not to do so for long, for within ten minutes of setting out the first car became bogged in a patch of soft sand, and all hands were gathered round it lifting and pushing to get it out again.

For most of us this was our first experience of driving over the soft - in places almost liquid - sand of the dune country, and at first it seemed incredible that any car, even when fitted with low pressure tyres, could make any progress at all without sinking into it. Not that desert tyres by any means render a car immune from sticking in sand - far from it - and, for we must on an average have got bogged 30 times each day.

"Debogging", however, soon became merely a matter of drill. The leading car for instance would sink in a patch of soft sand, and the other three which had been following approximately in its tracks would branch off to left and right until they were certain they were on hard sand, and there stop. All hands would then dismount and gather round the car in distress. If it was not a bad case it would probably suffice to scoop away the sand forming ~~in~~ a channel in front of the wheels, and then drive it out while the back was lifted and pushed to take the weight off the rear axle. But where a car was badly bogged it was necessary to let the tyre pressures down to 6 or 7 lbs. before it could be extricated. On the face of a hill the best method was generally to drive out backwards and then take another run at it.

During this first morning out from SIWA we encountered some of the most difficult country during the whole trip - both from the point of view of rough going and navigation. The dunes here were not in orderly lines such as are to be found further South, but clustered together in a tangled mass. This meant that frequent halts had to be called - apart from those necessary for debogging cars - in order to climb to the top of a sand dune and make a reconnaissance. To avoid the worst tracts of country tremendous detours had to be made which kept forcing us too far South off our course, and for a long time it seemed almost impossible to increase the distance between ourselves and KHAMISA which obstinately remained on the horizon. Our intention was to pitch our first camp as near to the LIBYAN FRONTIER as possible, which meant making good a course of approximately S.W.

At 12.30 p.m., we halted for luncheon having only covered a distance of approximately 30 kilos in a straight line from SIWA, although the speedometers of the cars showed almost double that mileage. Luncheon lasted approximately an hour, and by 1.30 p.m., the cars were loaded again and making good going over hard, firm sand on an almost due Southerly course. When latitude 29°N. had been reached, it was discovered that the dunes towards the South were grouped in ordered parallel lines bearing approximately 335° - 155°T, and these we crossed in a Westerly direction whenever easy places occurred. More Westing could have been made at the expense of considerable time and trouble in looking for possible crossing places over the dunes. This, however, was considered to be not worth while, and our original idea of camping close to the border (we had intended to visit the Cairn of Petrol Tins 28 34N, 25 02'E) was abandoned,

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/abandoned.

and it was decided to maintain our Southerly course.

At 3.30 p.m., we encountered the first trace of vegetation we had seen since leaving SIWA in the form of two stunted shrubs whose foliage suggested that they might have been of coniferous origin. Near the base of these bushes were some whitened bones thought to be those of migratory birds which had been attracted by the vegetation in the hope of finding water there. This proved to be an equally unlucky place to halt for birds and men, for all four cars became badly bogged. Indeed, we were to discover later that the presence of bushes nearly always indicated patches of soft sand.

A few miles further South we came to a rocky outcrop at the foot of a steep dune under the Eastern side of which we pitched our first camp (28°29.5'N, 25°13'E). The camp consisted of two 8 foot square tents which were occupied by Major W. Green and Group Captain W. McClaughry, Squadron Leader F. Mackworth and Flying Officer B. Blair-Oliphant, and a smaller tent for Air Chief Marshal Sir Robert Brooke-Popham. Bivouacs constructed with the Ford cars and tarpaulins provided accommodation for Sergeant Woffindin and the Native drivers, and a kitchen was improvised with provision boxes and another tarpaulin in the lee of Squadron Leader F. Mackworth's tent which also served as a Dining tent. The wireless gear was erected, and contact made with ISMAILIA, MERSA MATRUH and HELIOPOLIS, and as the result of a satisfactory message being received from the latter station the C.in.C. decided to extend the trip by an extra day. Dance music and the "Empire News" were received during dinner, and Squadron Leader F. Mackworth was able to check his Chronometer with the Greenwich time signal before finding our position by the stars. This proved to be only slightly at variance with the dead reckoning position obtained from the sun compass and speedometer readings.

29th. December. 1935.

The following morning breakfast was served at 6 a.m., but it was not until 8 o'clock that all the camp equipment had been packed up, and the cars loaded ready to start. A Southerly course was still pursued with occasional deviations to S.S.E. and many patches of soft sand were encountered early in the day's run.

It was again noticed that these patches occurred most frequently in the vicinity of bushes, and it was decided to give vegetation a wide berth in future. Apart from this, however, there were no reliable indications of the presence of soft sand which may occur anywhere.

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/anywhere.

Soft patches were frequently encountered on sloping sand about 500 yards, to the West of a sand dune, while whale-backs and tracts marked with irregular surface ripples were almost invariably found to have a hard surface. The most important thing to avoid is breaking through the surface of the sand, and for this reason, the clutch should always be let in very gently. Gear changing on a slope and use of the brakes almost invariably cause the hard surface sand to be broken, with the result that the car becomes bogged.

One of the main difficulties of driving in the desert is due to the fact that the colour is generally very uniform, and this, combined with the glare, makes it very difficult to perceive gradients. Generally speaking, the slopes appear much steeper than they really are. It is also quite easy to be false crested. A stretch of desert that looks perfectly flat may in reality contain a deep dip, but for the reasons mentioned above, the near edge of the dip merges into the far edge so that they appear to form one continuous surface.

When latitude 28°N was reached, it was decided to proceed East, crossing the dunes whenever a suitable gap or a whale-back was found. Very few easy passages were found, however, for in this region the dunes are exceptionally long, and for the most part have crested tops impassable for a car. We were therefore obliged to maintain our S.S.E. course, and it was not until the following day when 27°15'N, 25°30'E. was reached that any appreciable Easting could be made.

A halt was called at 12.45 p.m., for luncheon. Owing to the fact that we wanted to make as many hours running as possible each day, this meal was always in the form of a cold picnic lunch - meat and salad, followed by tinned fruit and cheese - which could be served and packed up again quickly. It usually lasted about an hour, and so rested the drivers and gave them an opportunity to refuel and check over their cars.

Good going was made during the afternoon over firm sand until 4.45 p.m., when a suitable site was found under the lee of a sand dune for our second camp. (27°33.3'N, 25°47'E). The tracks of a Jerboa were found crossing the top of the sand dune behind the tents, and the site was accordingly christened "JERBOA CAMP".

Some difficulty was experienced with the wireless at this camp owing to the fact that the mast cracked and had to be repaired, and then the transmitter at ISMAILIA broke down for half an hour. Contact was successfully made, however, and a signal was sent off to HELIOPOLIS postponing for 24 hours the arrival of the aircraft which had been ordered to take us back from SIWA on New Year's Day.

Our position was found by the stars, and differed from the D.R. position by only 6 kilometres.

The party retired to bed at 9.30 p.m.

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30th. December, 1935.

To enable us to make an earlier start, breakfast was served outside, and the drivers were therefore able to strike tents and start loading the cars while the meal was still in progress. The time occupied in striking camp and packing up was considerably shortened - it was found that all routine work was speeded up on each successive day during the trip - and the cars moved off shortly after dawn. Before leaving, a cairn of petrol tins and boxes was erected on top of the sand dune to mark the site of Jerboa Camp.

The first car became stuck within 5 minutes of starting off, but after it had been extricated a good spell of easy running was made on a S.E. course, and we were lucky in finding several whale-backs over the dunes which saved us having to make detours. Group Captain W.A. McClaughry led during the greater part of the morning which was uneventful with the exception of a puncture which occurred just before luncheon.

The lie of the dunes continued to force us further South, ~~and it was not until we were on a latitude South~~, and it was not until we were on a latitude South of AIN DALLA (27°15'N, 25°50'E) that substantial progress in an Easterly direction could be made. We stopped for luncheon at 12.30 p.m., for an hour, and then set course E.N.E. and made fairly good going with the exception of one particularly bad patch on the Western slope of a dune where 20 minutes were spent in extricating two cars.

also shorter
It was noticed that the dunes were now becoming fewer, and flattening out to produce a more open, rolling type of country, and at 4 p.m., patches of rock outcrop were sighted. The whole of the journey up to this time from approximately 29°05'N, 25°25'E had been made over sand, but after 27°N, 26°30'E rock was encountered in the valleys.

As it was obvious that we should be unable to reach AIN DALLA before sunset, we halted for the night after another hour's driving and pitched our third camp at the foot of a dune. On fixing our position (26°57.5'N, 26°45'E) by the stars, it was found that we were even further South than we had estimated from our dead reckoning. This was no doubt due to the fact that every dune that we had encountered during the afternoon had been evaded by making a detour to the South, thereby throwing us off our intended course of 80°T.

31st. December, 1935.

Dew was experienced for the first time on this morning, moreover it was exceedingly cold, and several members of the party remarked that stepping out of bed on to the sand was like treading on snow.

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At 7 a.m., we started off on a Northerly course and the cold was further intensified by travelling at 30 k.p.h. in open cars with the windscreens flattened. It was not until the sun was well up in the sky that it became warm enough to remove our Sidcot linings and leather coats. Good going was made, and after 15 minutes we ran on to large patches of gravel, and shortly after this a bird was seen - the first we had observed since leaving SIWA. A halt was called at 7.30 a.m., and from the top of a dune we sighted a large limestone plateau to the East which was thought to be EL GUSS ABU SAID.

At 8 a.m. we arrived at a cairn of old petrol tins and boxes surmounted by a whisky bottle, also car tracks running in a S.W. direction over gravel. This cairn is marked on the map (27°04'N, 26°46.5'E), and was thought to be an old camp site - either one of Clayton's surveying expeditions or of Kemel el Din and Dr. Ball's expedition. The whisky bottle was empty, so a message was written and placed inside which read as follows :-

"Air Chief Marshal Sir Robert Brooke-Popham
"and Green Bey, Governor of the Western Des-
"ert, visited this Cairn on their way across
"the SAND SEA 31.12.35."

"Sorry this bottle is empty, turn up an empty
"glass".

The tyre pressures which had been maintained at 6-8 lbs, while we were driving over sand were now increased to 10 lbs for running over the gravel surface. We were at this time in the area marked on the map as NUMMULITE SCARP, but although search was made on several occasions, we were unable to find any Nummulites.

A course of N.N.E. was followed from the cairn which brought us on to rolling sand once more, and very good going was made for an hour over "switch-back" country having a good hard surface. At 9 a.m., we were confronted by a limestone ridge, and as there was no way over it passable for a car, we were compelled to retrace our tracks for 4 or 5 kilometres in order to drive round it. Half an hour later we were driving between isolated rocky plateaux similar to those which lie a few miles north of SIWA, and another detour had to be made to avoid a very sheer descent. From this place TABLE HILL was sighted for the first time.

The plateaux which were numerous in this part of the desert were remarkable for their strikingly regular and symmetrical shapes. Some were oval, others formed in circular steps, while here and there were perfectly conical heaps of gravel which bore a striking resemblance to the shale heaps of the mining areas in the lowlands of SCOTLAND. The rock formations also were carved into strange and fantastic shapes, and many of them contained fossilized shell organisms.

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At 10.30 a.m., we again encountered gravel bearing traces of old car tracks which terminated abruptly in the base of a steep dune. This gave some indication of the rate at which the dunes change shape, for these tracks, which were only a few years old, must originally have continued up the side of what was then a gentle incline, and which had since developed into a steep, bulging slope quite impassable for a car.

Shortly after this we ran on to an area of ground to the West of TABLE MOUNTAIN which was covered with perfectly spherical stones about the size of cricket balls, and curiously shaped pieces of a white marble-like substance. Both of these when cracked open revealed a crystalline formation inside, and the spherical specimens were hollow to a diameter of about $1\frac{1}{2}$ inches.

AIN DALLA was sighted at 11.30 a.m., and after another 20 minutes running - now entirely over gravel - we arrived at the oasis, having passed two more old camp sites. The oasis consists of a small mound on the top of which is the well, surrounded by a clump of bullrushes. There are a few palm trees and other shrubs, and the desert for a distance of approximately a quarter of a mile all round is dotted with raised clumps of coarse dry grass. The well has been lined with concrete and the water is led ~~out~~ by a pipe to a spot about 20 yards S.W. where it flows out - luke warm - at about the rate of flow of a bath tap. On top of the hill is a small wooden hut which is used for storage of petrol and materials for cleaning and repairing the well.

The whole party enjoyed a most welcome wash, after which we sat down to luncheon while the drivers refilled the empty containers and loaded on the new petrol supplies from a small store which had previously been despatched to AIN DALLA by the Governor on Camel convoy.

At 1.15 p.m., we started on the homeward journey on a course of 3100T, and after three hours driving arrived at the SANDSTONE KNOLL (27°41'N, 26°49'E). This stretch was the roughest going encountered during the whole trip, the surface of the desert here being composed very largely of rock, and strewn with boulders and large stones. Almost immediately after leaving the SANDSTONE KNOLL we found ourselves in the dune country once more with occasional outcrops of rock and gravel patches at the bottom of the valleys. The dune lines were followed N.N.W., and crossed in a Westerly direction whenever a suitable pass was found.

Camp was pitched at 4.25 p.m., at 27°44'7"N, 26°42'E, and the remaining hour before sunset was occupied by excavating the base of a sand dune. Our efforts threw very little light on the problem of dune formation, but provided strenuous exercise and a good deal of mirth. After dark we sat round a fire of petrol boxes, and listened to the New Year's Eve broadcasting programme from Daventry. New Year Greetings were also exchanged by W/T with MERSA MATRUH, HELIOPOLIS and PALESTINE.

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Very heavy dew and intense cold were again experienced in the early morning, and as excellent going was made on a course between and parallel to the dunes, no opportunity was given us to get warm from the exertion of pushing bogged cars. It was not until 11 a.m. that any appreciable warmth was felt from the sun. Having failed to locate the Two Knolls marked on the map at $28^{\circ}08'N$, $26^{\circ}09'E$, we altered course for ECHO VALLEY and at 12.10 p.m. sighted a cairn to the North which Major W. Green said he had built on a previous expedition, and which lay 100 kilos from SIWA.

A halt was called for luncheon at 12.30 p.m. and we set out again an hour later, estimating that we should arrive at SIWA about an hour before sunset. This, however, was not to be, for at 1.45 p.m. the leading car broke a back axle, losing its rear wheel and subsiding into the sand over the brake drum. Luckily the car was not travelling fast at the time, and no other damage was sustained. After it had been unloaded, the back of the car was lifted on to a 16 gallon water tank, and the three Native drivers set to work to change the axle. The job was completed in exactly $2\frac{1}{2}$ hours - including a short break for tea - and by 4.30 p.m. everything was reloaded and ready to move on again. Before leaving the scene of the accident, a cairn was built with the broken half-shaft protruding from the top.

It was now obvious that we should be unable to reach SIWA before sunset, but as our position was not very certain it was decided to push on for an hour, and if SIWA had not been sighted within that time to pitch camp before dark. At 5.15 p.m. after a stretch of good running at full speed, a very steep dune was encountered on the far side of which lay a tract of broken dune country, and it was decided to stop for the night.

Camp was pitched very quickly, and ^{the} at 6.30 time signal was received from Greenwich to enable us to check our positions by the stars. Wireless messages were also sent out explaining our delay.

It was found that we were still 44 kilos from SIWA at a position $28^{\circ}55'N$, $25^{\circ}51'E$.

2nd. January, 1936.

The morning was considerably warmer than that of the previous day, and no dew had fallen. After an early start good going was made until 7.30 a.m. when two punctures occurred almost simultaneously. At 8.30 a.m. camel tracks leading in the direction of LUBBAQ were crossed, and ten minutes later KHAMISA was sighted.

The Rest House at SIWA was reached at 9.15 a.m. and, after a brief halt to collect baggage which had been left there, the party drove out to the landing ground to be flown back to MERSA MATRUH, having been in the desert for 5 days during which time a distance of 824 kilometres had been covered.

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The sea for about ten miles South of SIWA is very difficult to traverse in a car. It is a tangled mass of sand dunes running in all directions. On one occasion we saw a main line of sand dunes running North and South, subsidiary sand dunes running East and West, and still smaller ones running North and South from off the latter.

As one goes further South the dunes gradually become more regular and from about 20 miles South of SIWA onwards form lines running almost parallel from North by West to South by East.

The original surface of the SAND SEA was apparently lime stone. The height of the sand dune above the lime stone may be anything from 100 to 300 feet. Throughout the greater part of the area we crossed, a section of the dunes would resemble a ratchet with the steel side of the ratchet facing East. The edge of the ratchet would be formed by dunes, and sand appeared to have blown up against these dunes from the West.

A car travelling East and approaching a sand dune from the West would go up a more or less regular slope and at the end would reach a light coloured crest of soft sand. Walking to the top of this sand and looking over, one could see what appeared to be a deep valley at the bottom of a deep sand slope. Beyond the valley would again be an area of sand steadily rising towards the West and again ending in a dune line.

It was comparatively easy to reach the top of the dune by car from the West, but almost impossible to get down. Occasionally a pass down the dune would be found, but normally it was necessary to go round the end of it.

Some of the dunes encountered during the first three days were found to be 15 kilometres in length and these appeared to be about the normal, but East of longitude 26° 30' most of the dunes were much shorter than those further West, some of them being only about one kilometre in length. On the Eastern edge of the SAND SEA, however, the dunes again became much longer.

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APPENDIX "B".

N A V I G A T I O N.

The following navigational instruments were carried :-

- 2 Sun compasses (fitted to Cars No. 1 and 3).
- 1 P.6. Aircraft Compass (fitted to Car No.2).
- 1 Theodolite.
- 1 Chronometer.
- 1 Altimeter.
- 1 Survey of Egypt Map, 1/500,000, Sheet 4. (1935 edition).
- Dividers, Protractor, Astronomical Tables.

Navigation was carried out mainly by Sun compass combined with speedometer readings. The sun compass was found to be somewhat difficult to steer by during the ~~last~~ hour after sunrise and the hour before sunset.

The P.6. aircraft compass, which was installed and swung before leaving MERSA MATRUH, was not very accurate from a directional point of view although a steady course could be steered by it. Readings on Northerly and Southerly headings were reasonably accurate, but a large deviation was registered on East and West.

Although continuous alterations of course were found to be inevitable, a mean of the minor variations was taken and the dead reckoning track plotted.

At night, position was found by astronomical observation. ^{the} D.R. error varied between a minimum of 2 kilometres and a maximum of 12 kilometres in a day's run.

The following table shows the positions of the camps and their heights above sea level, together with the mileage recorded each day :-

D A T E.	CAMP	POSITION.	HEIGHT	MILEAGE RUN (Km).
28-29/12/35.	1	Lat. 28° 29.5' N. Long. 25° 13' E.	187	110
29-30/12/35.	2	Lat. 27° 33.3' N. Long. 25° 47' E.	491	142
30-31/12/35.	3	Lat. 27° 57.5' N. Long. 26° 45' E.	532	148
31/12/35 -) 1/1/36.)		Lat. 27° 44.7' N. Long. 26° 42' E.	Not recorded	177
1-2/1/36.		Lat. 28° 55' N. Long. 25° 51' E.	Not recorded	177

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APPENDIX "C"

W I R E L E S S .

The Wireless apparatus used was composed of Royal Air Force service equipment which had been modified to meet the requirements of the expedition and built into a crate specially designed and manufactured by Sergeant Woffindin, No.142 (L.B) Squadron, Royal Air Force. The portable wooden mast was also designed and made by Sergeant Woffindin, and the following description of the apparatus and its performance has been drawn up by him :-

Requirements of the Apparatus.

- (a) To provide communication between the expedition, Headquarters, Middle East and Headquarters, Truforce.
- (b) To obtain time signals which were necessary for correcting the chronometer.

Description of Apparatus.

- (a) A T.25B transmitter and R76 receiver were used. The transmitter, which is normally an aircraft R/T transmitter, was converted into a continuous wave transmitter by keying the H.T. supply and introducing a spark suppressor.
- (b) Normal power supply was used in the form of a small motor generator and the necessary accumulator to drive it.
- (c) The aerial system consisted of a portable wooden mast 20 feet in length, and the actual system of a half-wave Hertz aerial measured for the allotted frequency of 6500 K/cs.
- (d) The complete station was designed for absolute portability consistent with being capable of withstanding heavy shock and vibration.

Performance.

- (a) All communication was carried out without difficulty except on the morning of the 28th. December, 1935. I am of the opinion that the two hours before dawn at this season constitute a complete fade-out on 6500 K/cs., and, this opinion is further supported by the experience of the previous morning when communication with Headquarters, Truforce was not established until 0718 hours.
- (b) Three daily periods had been allocated for W/T watches, but owing to the fact that the expedition was on the move from sunrise till sunset, each day, it was impossible to adhere to this allocation, and it was decided to operate on the evening period only.
- (c) Although the various sites on which the station was erected were poor from a wireless standpoint, the sets proved to be capable of doing the work required, and no difficulties were encountered.

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APPENDIX "D"KING'S
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In addition to the tents previously mentioned, two folding tables, five camp chairs and two primus lamps completed the camp equipment carried. The Primus lamps greatly added to the general comfort as the light given by them is far superior to that of the ordinary hurricane lantern. They were carried in specially made wooden boxes, and suffered no damage in transit. Members of the expedition brought their own valises, and in some cases camp beds.

A first-aid box was carried.

Messing.

Provisions carried were entirely tinned or dry with the exception of bread, butter, fresh fruit and vegetables. Daily menus were drawn up beforehand, and each day's rations were packed in separate box. A reserve box containing rations for 1½ days was taken in case of emergency, and these were partly consumed as a result of the accident which occurred on the afternoon of the 1st. January.

A galvanised iron hay-box was used for the storage of green vegetables and butter with the result that these were kept in a fresh and cool condition throughout the trip.

Water was rationed to 1 gallon per head per day for all purposes, and this allowance proved to be ample for our requirements.

Cooking was done on 3 Primus stoves and an R.A.F. Messing box and cooking box provided cutlery, plates, cooking utensils etc., sufficient for our requirements.

The following is a list of daily Menus. :-

28th. December, 1935.

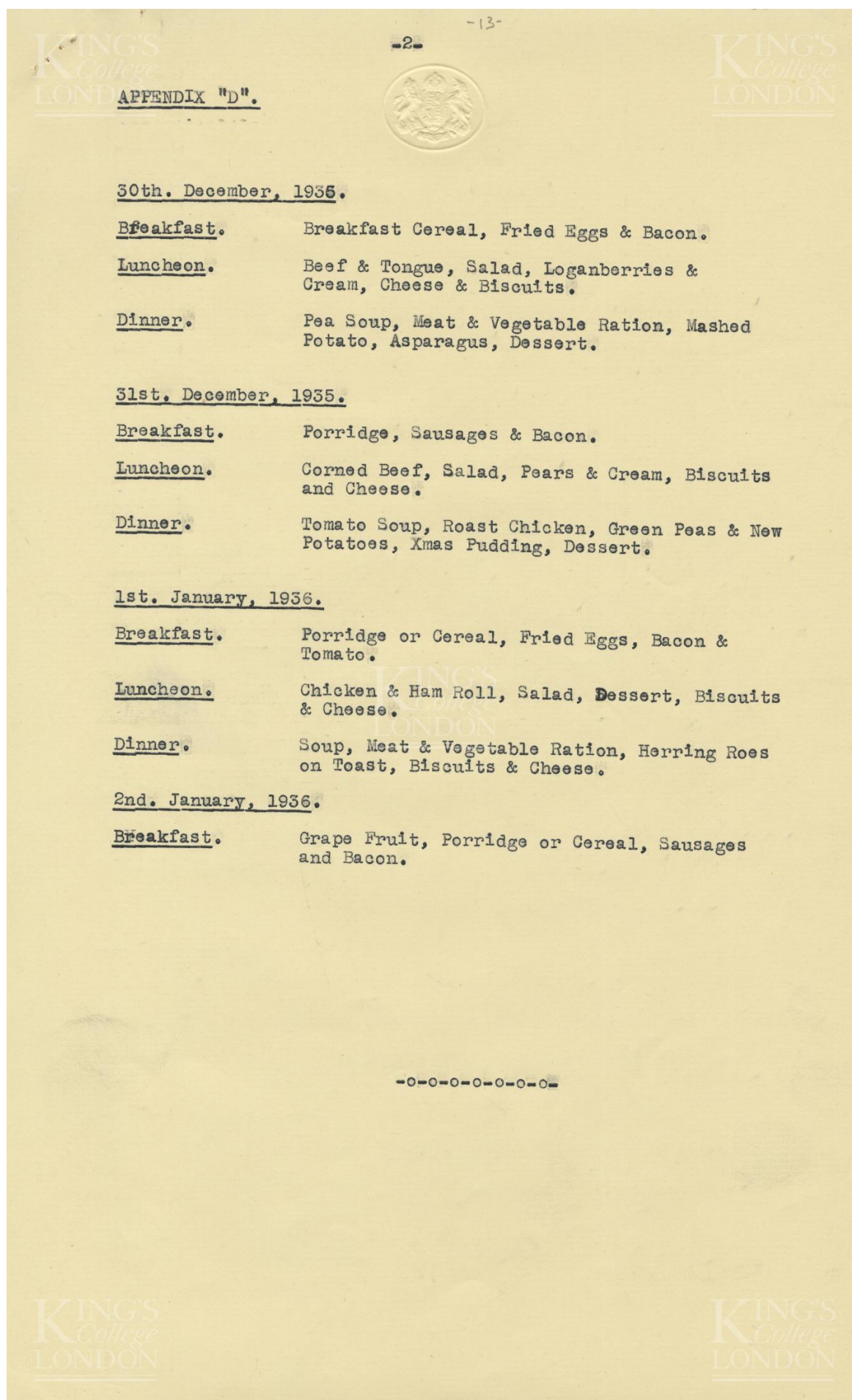
<u>Breakfast.</u>	Breakfast Cereal, Fried Bacon, Eggs and Tomatoes, Marmalade.
<u>Luncheon.</u>	Corned Beef, Salad, Fruit Salad, Cheese & Biscuits.
<u>Dinner.</u>	Mulagatawny Soup, Meat & Vegetable Ration, Stewed Celery and Mashed Potatoes, Devilled Sardines.

29th. December, 1935.

<u>Breakfast.</u>	Breakfast Cereal, Scrambled Eggs & Bacon.
<u>Luncheon.</u>	Chicken & Ham Roll, Salad, Peaches & Cream, Cheese & Biscuits.
<u>Dinner.</u>	Pork Sausages, Heinz Beans & Mashed Potato, Biscuits, Grape fruit, Cheese & Biscuits.

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THE PYRAMIDS.

* * * * *

The Ancient Egyptians built their towns, houses, palaces and temples on the edge of the desert. Their cemeteries were usually situated in the desert to the west of the Nile so that the last journey would be towards the setting sun. The agricultural land on each bank of the Nile was flooded by the annual high Nile and so could not be used either as a town site or a cemetery. Believing in a future life, the Ancient Egyptians took great care to preserve the bodies of their dead by embalming; they also placed in the tomb personal belongings, clothes, jewels, furniture etc. for use in the after life. In order to preserve these objects a large and substantial tomb had to be built. The earliest built tombs, called mastabas, were large structures made of stone blocks or bricks. The ground plan was rectangular and the walls sloped inwards at an angle of about 80°. The burial chamber was often below ground level at the bottom of a vertical shaft. In the east wall there was a niche or false door at which offerings were made and prayers recited. A mortuary chapel was frequently built in front of this recess.

As funerals became more elaborate the mastaba gave way to the pyramid which is essentially a large tomb. The mortuary chapel became the mortuary temple situated immediately to the east of the pyramid. In some cases another temple was also built at the edge of the cultivation, and joined to the mortuary temple by a paved road. This is the valley temple. The pyramid did not take the place of the mastaba as soon as it was evolved. Shepseskaf, the last pharaoh of the IVth. Dynasty was buried in the "Mastabat Fara-un" at Saqqara some 150 years after the first pyramid was built. Some of the mastabas are very large, much larger than the smaller pyramids but none is as large as a big pyramid. It is not always easy to decide whether some particular tomb is a pyramid or a mastaba. Thus the step pyramid at Saqqara, which measures 413 by 344 feet is often called the step-mastaba and the last pyramid to be discovered at Giza (No. 11 on map) is described by some authorities as a mastaba.

All the pyramids have at least one burial chamber; some of them have several which are entered through long passages which were originally closed by mighty blocks of stone and concealed by the outer casing. As long as there was a strong Government the pyramids and the mastabas were carefully guarded and kept intact. With the collapse of the VIth. Dynasty the tombs were systematically robbed so that only in a very few instances have mummified remains been found in modern times.

Pyramids remained in fashion for royal burials for a period of 1000 years and they are to be found in groups along the edge of the desert for a distance of 60 miles from the Faiyum in the south to Abu Roash in the north. Of the seven major groups of pyramids the most famous is that of Giza. There are eleven pyramids at Giza of which eight are small and need no description. The three large ones will now be described.

THE GREAT PYRAMID.

This was built by Cheops, the second Pharaoh of the IVth. Dynasty who reigned for 23 years and died about 3000 B.C. It is the largest building in the world and covers an area of 13 acres. The four sides originally were each

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756 feet long and the original height was 481 feet. Casing stones of white limestone from Toura can still be seen in the centre of the north face and they should be carefully examined. The joints between successive stones are no thicker than a piece of paper, some of the blocks weigh 10 tons. At the west end of these casing blocks there are cunningly concealed modern steps which are worth finding as it is most interesting to walk about on the top of these blocks and see how they are fitted into each other, and into the stones behind. When the stones were laid only three of the six faces were usually smooth, the base, the back and one side. The other side was then dressed to receive the next block and the marks of the tool used to dress the side face can still be seen on the block below in places where the upper block has been removed. When a whole course had been laid the upper surface of all the blocks was dressed level and smooth at one operation. Finally when the building was complete the outside faces were dressed and smoothed. The exquisite workmanship displayed in fitting the casing stones of the Great Pyramid has never since been equalled. The stones at the back of the casing are not nearly so carefully fitted, the rising joints are not vertical and great gaps in the masonry are filled up with mortar. The entrance to the Great Pyramid is in the north face. There are several chambers inside connected by steep low passages. The entrance passage passes at regular intervals every 15 feet through the middle of enormous blocks of stone. We are unable to explain the reason for this. It has been calculated that 2,300,000 blocks were used in the Great Pyramid and its total weight is more than six million tons.

THE SECOND PYRAMID.

The Second Pyramid was built by Chephren the fourth Pharaoh of the IVth. Dynasty who reigned for 29 years. He came to the throne on the death of Dedf-re who only reigned 8 years and built a pyramid at Abu Roash. The sides of the Second Pyramid were originally 708 feet long and the height was 471 feet. Owing to the fact that it stands on higher ground and that it has suffered less damage at the top than the Great Pyramid, it stands higher than the Great Pyramid although it is slightly smaller in size. The ground on which it is built was originally sloping and had to be levelled. The stone removed in this operation was used in the construction. The method of surface quarrying used by the Ancient Egyptians is revealed by an examination of the ground immediately to the north of the pyramid. Narrow parallel trenches, 4 to 6 feet deep and 8 to 10 feet apart were first cut. Trenches at right angles were then made isolating individual blocks. Holes were then drilled under the blocks which were finally severed probably by means of wooden wedges. In some of the corners of this pyramid, there are huge blocks of stone, they are the biggest stones used in any pyramid.

Immediately to the east of the Second Pyramid is the mortuary temple. This should be examined particularly at the end near the pyramid as there are fine examples of a single stone forming parts of two walls at the corner of a room. This is a proof that the walls were built in the rough and finally dressed smooth.

THE THIRD PYRAMID.

Mycerinos, the fifth Pharaoh of the IVth. Dynasty, reigned for 18 years. He built the Third Pyramid.

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The original height was 218 feet and the side of the base 356 feet. This pyramid is remarkable for the fact that the lower courses of the casing stones are composed of Aswân granite and have never been completely smoothed. Bosses project from the faces of these blocks and were evidently used to lever them into position. Perhaps these stones were too hard to dress but it was fortunate for us that they were left as they are because we can learn a great deal from them about Ancient Egyptian methods. It should be noticed that the rising joints on the east face behind the wall of the mortuary temple are not vertical.

THE SPHINX.

Most of the stone used in the construction of the Great Pyramid was got by surface quarrying to the south east. As the surface was lowered a curiously shaped mass of yellowish limestone was revealed. As this was unsuitable for building it was left. Layer by layer the surface was removed until this rock stuck up to a considerable height above the quarry floor. When building the Second Pyramid, Chephren used the same quarry and then it was noticed that this curious rock bore a rough resemblance to the crouching body of a lion. It was accordingly carved into the shape of a Sphinx. The head is adorned with the royal head dress and serpent. The length of the Sphinx is 240 feet and the height from the floor to the crown of the head is 66 feet. The Sphinx was a sentinel on guard outside the wall of the sacred enclosure of the Second Pyramid. The Uraeus (the sacred serpent), from the head is now in the British Museum.

Near the Sphinx is a temple, the so-called temple of the Sphinx. Actually it has nothing to do with the Sphinx but it is the Valley Temple of the Second Pyramid to which it is joined by a road paved with stone. The huge blocks of Aswân granite forming door lintels should be noted.

PROBLEMS OF THE PYRAMIDS.

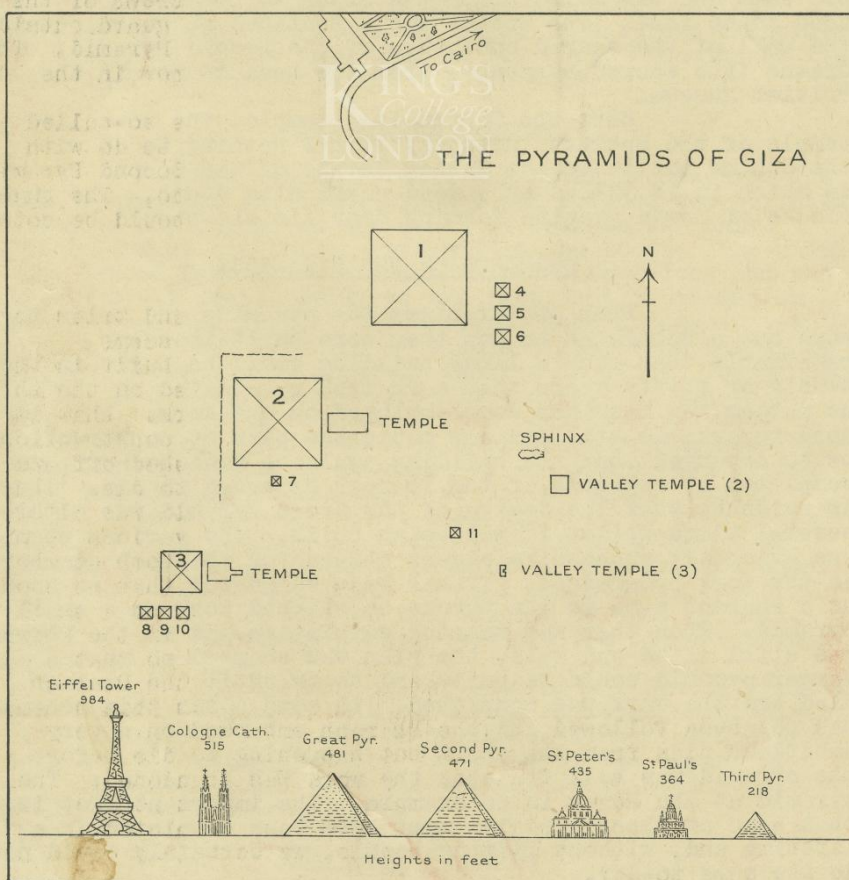
When one examines the pyramids and tries to work out a scheme as to how they were built it seems remarkable that such a large building could be built in the twenty or thirty years that a Pharaoh was seated on the throne no matter how many men were employed on the work. What is more remarkable still is how could the plan of construction be so arranged that the building could be finished off and completed at any time if the Pharaoh happened to die. There is evidence that the design of the Great Pyramid was altered several times whilst it was being built. The various chambers are evidently successive places chosen for the tomb chamber as the work progressed. It has been suggested that as soon as a Pharaoh came to the throne he started work on a small pyramid. When that was nearing completion and if the Pharaoh was still alive and well, the plan was changed so that a larger pyramid could be built and so on until the Pharaoh died and the work was completed. In some cases this scheme has not been followed and the Pharaoh embarked on a very ambitious plan from the start but happening to die before the pyramid was half finished the work was abandoned. The pyramid at Abu Roash is an example. The important fact is that each of these pyramids must have been completed in a lifetime and, without lifting tackle, we certainly could not do the same to-day.

Each of the three large pyramids at Giza has a ground plan which is practically a perfect square facing

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The four sides of the Great Pyramid are all of the same length within four inches. The platform on which it is built is truly horizontal within an inch. We attain this accuracy to-day by using instruments fitted with telescopes and accurate spirit levels which the Ancient Egyptians did not possess. What instruments did they use ?

F. S. R.



AUGUST 1936